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STUDIES OF THE FAUNA OF THE BERTIE FORMATION[1]

JOSEPH W. MONAHAN

I. INTRODUCTION.

The present studies are the by-product of a partial reclassification of the paleontologic collections of the Buffalo Society of Natural Sciences. In the course of this work, it was the desire of the Board of Managers of the Society that particular attention be paid to the collections from the Bertie formation.

The collecting zeal of the late Lewis J. Bennett, a former member of the Board of Managers, has made this collection perhaps the finest representation of this very interesting and puzzling fauna in existence. Over a period of about twenty-five years Mr. Bennett kept close watch on quarrying operations at the Bennett quarries in North Buffalo, and, as periodic stripping exposed the eurypterid bearing Williamsville waterlime bed, missed but few fossils in his collecting. Of this material by far the greater part is now in the possession of the Buffalo Society of Natural Sciences.

It is felt that the lack of detailed knowledge concern-

[1] Read before the Paleontological Society, December 27, 1929, under the title of "Additions to the Description of the Fauna of the Bertie Waterlime," (Bull. Geol. Soc. Am., vol. 41, p. 204, 1930). Received for publication in November, 1930, but not edited until after Mr. Monahan's death on December 1 of that year. Only minor changes in format have been made, with re-arrangement of illustrations approved by Mr. Monahan shortly after receipt of the manuscript.—C. L. F. and M. A. F.

ing the waterlimes of western New York, and the rarity of the fossil material from them, justify the publication of research that necessarily is incomplete. The recent work of Ruedemann on Ontarian faunas has tremendously increased our knowledge of the animals of the waterlime association; nevertheless there must certainly still exist, scattered in smaller collections from the waterlimes, many undescribed forms. A study of these forms would do much to complete our understanding of conditions during the periods of waterlime deposition.

Still more important is a better and more detailed understanding of the field relations of the entire Bertie. Chadwick and Hartnagel have done important pioneering work in this respect, and the knowledge they have made available emphasizes the misunderstandings current concerning the group, and the great need of further field studies before reliable conclusions can be drawn. It is further worth noting that the greater part of the Salina group as developed in western New York, the mass to which the term "Camillus" is commonly applied, is little better understood than it was at the close of Hall's work on the Fourth District of New York State.

I wish here to express my great indebtedness to the following individuals for assistance in the preparation of this research: to Doctor C. L. Fenton and Mrs. M. A. Fenton, for advice in the preparation of manuscript and plates, to Doctor Rudolf Ruedemann for the use of types in the possession of the New York Museum, and for advice concerning the relationships of certain forms, to Mr. C. A. Hartnagel and to Professor George H. Chadwick for opinions on the stratigraphy of the Bertie, and to Mr. Martin G. Schnekenburger and Mr. Charles E. Simmons of the photographic division of the Buffalo Society of Natural Sciences, whose photographs have been used in the preparation of the plates.

II. THE BERTIE FORMATION IN GENERAL.

The series of waterlimes and dolomites to which the term Bertie is applied have been subdivided in the Buffalo region, as follows, by Chadwick (1930):

Akron dolomite
Williamsville waterlime
(Cement bed)
Scajaquada shaly beds
Falkirk dolomite
Oatka shaly waterlimes

The close relation of the Akron dolomite to the remainder of the series has been emphasized by Hartnagel (1905), Ruedemann (1925), and Chadwick (1930). A recent paper by Newland (1929), however, returns to the application of the name "Cobleskill" to this bed.

Of the forty-four Bertie species previously cited by Ruedemann (1925), to which the present paper adds nine, all probably are from the Williamsville waterlime. Outside of the Buffalo region six species of eurypterids and seven non-eurypterid species are quoted from the Bertie. Of these thirteen forms two eurypterids, *Dolichopterus macrocheirus* Hall and *Pterygotus cobbi* Hall occur also in the Buffalo region. The gastropod *Hormotoma gregaria* Ruedemann is cited from Buffalo, from Marcellus, and from Litchfield. The poor preservation of the material of this latter species, together with the observed variation in size and number of whorls suggests that more than one species are included under the name. This marked difference in the faunas of the middle and eastern districts suggests strongly that the Bertie will prove, on careful study, as complex from the faunistic standpoint as it seems to be from that of sedimentation.

In the Buffalo region only a few unidentifiable eurypterid fragments are certainly known from the Scajaquada or Falkirk beds.

From the Akron dolomite the following species have been cited by various authors:

Buthotrephis clavelloides Grabau
Nematophycus crassus (Penhallow)
Cyathophyllum hydraulicum Simpson
Medusaegraptus graminiformis (Pohlman)
Inocaulis akronensis Ruedemann
Schuchertella interstriata (Hall)
Spirifer (Delthyris) eriensis (Grabau)
Whitfieldella subsulcata Grabau
Whitfieldella sulcata (Vanuxem)
Whitfieldella nucleolata (Hall)
Leperditia scalaris (Jones)
Pterygotus sp.

This list is in need of revision, but serves to demonstrate that the period to which the term Bertie is applied was long enough to have permitted considerable modification in marine life. Careful attention to the stratigraphic location of the occasional fossils retrieved from this forbidding mass may finally build up a series of faunas beneath the Williamsville as extensive as that of either the Williamsville or the Akron, and permit more exact correlation with strata outside the province. It may then prove that the sharply differentiated faunas of the middle and eastern districts owe their distinction from the fauna of the Buffalo district to differences in age; that they are from beds below or above the Williamsville or its eastern equivalent.

Considering more particularly the fauna of the Williamsville bed: The dominant place of the Eurypterida in this fauna has been repeatedly noted. Within this group the dominant place of the single species *Eurypterus lacustris* Harlan is an equally notable feature. Of somewhere over two hundred and fifty specimens of eurypterids in the collections of the Buffalo Society of Natural Sciences, about two hundred are of this species. Two other species, *Eusarcus scorpionis* Grote and Pitt, and *Peterygotus buffaloensis* Pohlman consti-

tute the bulk of the remaining eurypterids, the five additional species and one variety being of relatively sporadic occurrence.

A further list of eleven species, from the number of individuals representing them, and from their usually relatively good preservation, must be considered close associates of the eurypterids, and native to the same environment. These are:

Inocaulis lesquereuxi (Grote and Pitt)
Medusaegraptus graminiformis (Pohlman)
Lingula media Ruedemann
Hercynella buffaloensis O'Connell
Hercynella patelliformis O'Connell
Hormotoma gregaria Ruedemann
Pristeroceras timidum Ruedemann
Ceratiocaris acuminata Hall
Ceratiocaris maccoyana Hall
Leperditia alta (Conrad)
Leperditia scalaris (Jones)

This fauna is evidently a specialized one. The presence in numbers of *Lingula*, the "stalky" habit of growth of *Medusaegraptus graminiformis*, and the peculiar floating mode of life adopted by *Inocaulis lesquereuxi* suggest specialization for conditions of, at least occasionally, very rapid sedimentation. On the other hand, these freely floating colonies of *Inocaulis* would scarcely be adapted for the strong currents and unquiet waters that would be expected in a region of rapid sedimentation.

Many of the remaining species in the list are so specialized as to suggest that they, too, are natives of the same environment, but many others are of genera, such as *Camarotoechia*, *Delthyris*, *Loxonema*, and *Orthoceras*, so typical of normal marine conditions that they must have been alien to this specialized fauna. Without denying the efficiency of solution in destroying the fossils of the waterlime, it still seems necessary to regard these normal marine forms as in some manner stragglers from another environment.

This need not mean storm borne marine stragglers into a delta. The evidence now accumulating seems to bear strongly against the theory of a deltaic origin for the Bertie sediments. The work of Chadwick (1930) indicates the existence within the group of relatively thin units, fairly constant petrographically, and of far too wide horizontal distribution to be the products of delta formation. Such beds rather suggest widespread lagoon conditions to the landward of an epicontinental coral reef. The stragglers would then probably be from the environment of the seaward side of the reef, or of the littoral, carried into their present association by occasional abnormalities in current directions.

In connection with the eurypterids, a point worth mention is the absence of young forms. The collections of the Buffalo Society of Natural Sciences contain approximately two hundred specimens of *Eurypterus lacustris* which have been studied. This number includes the group of ten specimens, about 2.5 mm. long, referred by Ruedemann (1925), to this species. With the exception of these, however, the smallest specimen found is over 5 cm. long, by far the greater number being upward of 12.5 cm. in length. If it is assumed, (as is reasonable from the general nature of crustacean growth and the relatively great number of eurypterid fossils), that most of these fossils represent shed integuments, the opposite condition, that is, an abundance of young stages, would be expected. The presence of an occasional fragmentary specimen closely associated with probably scavenging Ostracoda, together with the rarity of small eurypterids, seems to indicate destruction of moulted integuments of the latter group.

The contrast of this dominance of the eurypterid fauna by mature forms with the state of things holding in the Litchfield region has been noted by Clarke and Ruedemann (1912). The occurrence in the Salina of this locality, in the Pittsford of Monroe County, in the Shawangunk conglomerate, and in other beds, of abundant and well preserved young eurypterids disposes of the supposition that the younger stages might have been too thin shelled for preservation. Clarke and

Ruedemann (1912) have suggested that the conditions at Buffalo might have been those of deep water, and the younger forms have clung for protection to the shallower waters nearer shore. Such a supposition would imply that most other deposits in which eurypterids are abundant were deposited in very shallow waters. There is nothing in the nature or distribution of such other beds, or in the nature of their contained faunas, to militate against this conclusion. On the contrary the restricted distribution and clastic character of the sediments strongly support it. As to the faunas associated with the eurypterids in these regions, too much remains to be done to permit any assertion more definite than that they show at least as much evidence of representing a marine littoral association, as one of any other type.

However, if the North Buffalo deposit is considered to be one of relatively deep water into which only the larger eurypterids would resort, there remains to be found an equivalent shallow water facies, which should retain the remains of the young forms. The Herkimer County Bertie cannot be regarded as such an equivalent facies, for the young whose remains are found there in such large numbers are of the species *Eurypterus remipes* Dekay, a form sufficiently distinct from the western *Eurypterus lacustris* to eliminate the possibility of confusion in dealing with immature specimens. So also with the other genera of the eurypterids; although they are common to both regions, they are represented in each by quite distinct species.

III. DESCRIPTIONS OF FOSSILS.

INOCAULIS LESQUEREUXI (GROTE AND PITT)

Plate II; Plate III, Fig. 1; Plate IV, Fig. 1

Buthotrephis Lesquereuxi Grote and Pitt, Bull. Buffalo Soc. Nat. Sci., vol. 3, p. 88. 1876.

Buthrotrephis Lesquereux Pohlman, Bull. Buffalo Soc. Nat. Sci., vol. 4, no. 1, p. 19, fig. 6. 1881.

Bythotrephis lesquereuxi Grabau, Bull. Buffalo Soc. Nat. Sci., vol. 7, p. 131, fig. 26. 1901.

Bythotrephis lesquereuxi Grabau, New York State Mus. Bull. 45, p. 131, fig. 26. 1901.

Buthotrephis lesquereuxi White, Proc. U. S. Nat. Mus., vol. 24, p. 268. 1901.

"Buthotrephis lesquereuxi" O'Connell, Bull. Buffalo Soc. Nat. Sci., vol. 11, no. 3, p. 87. 1916.

Inocaulis lesquereuxi Ruedemann, New York State Mus., Bull. 189, p. 13, pl. 4, figs. 1-4, text fig. 4. 1916.

Inocaulis lesquereuxi Ruedemann, New York State Mus., Bull. 265, p. 27, pl. 12, figs. 1-2. 1925.

Remarks.—This species was first briefly described by Grote and Pitt (1876) as a seaweed. Pohlman (1881) furnished, without description, a very misleading figure of a second specimen. Grabau (1901) substantially repeats the description of Grote and Pitt, and copies the figure of Pohlman. David White (1901), in describing two new species from the Kokomo waterlimes of Indiana (*Buthotrephis divaricata* and *B. newlini*) calls attention to the close relationship of these two forms with the Bertie species, and, discussing the genus *Buthotrephis*, summarizes evidence against the relation of the three to the sponges, and favoring their alliance with the algae. He further calls attention to the resemblance of these forms to species of the graptolite genus *Inocaulis*. Ruedemann (1916) elaborately redescribes the species, largely from new and splendidly preserved material, also figuring for the first time the Grote and Pitt type. He places the species in the dendroid graptolite genus *Inocaulis*, near the group of *Inocaulis vegetabilis, ramulosus, diffusus,* and *plumosus*. Reviewing the work of David White, he is led to admit the possibility of algal affinities, but considers a relationship with the Dendroidea as more probable. The same author later (1925) published two further figures of the species, one of a specimen a foot in width, also adding a number of morpho-

logical details, and describing a very closely related form from the Akron dolomite as *Inocaulis akronensis*.

The collections of the Buffalo Society of Natural Sciences contain a number of specimens of this species associated with thin films of tough, carbonaceous material, fairly circular in outline. Most of these films have a structureless appearance except for the region near the base of the stem, but one of them shows throughout an indistinctly fibrous appearance. The best preserved are densely black, smooth internally and very finely roughened externally. The uniformly circular outline, doubling of the layers, and absence of any evidence of internal filling make it probable that these films are the remains of thin-walled, inflated sacs.

The best specimen available is about 40 mm. in diameter. One point of the circumference shows an arcuate projection. This projection meets the base of the colony, the twisted fibres which make up the mass of the interior of the stem apparently passing out through its constricted base and into this projection of the sac, from thence spreading into its walls. Toward the circumference of the circle these fibres show crowding.

The stem, at its union with the sac, is about 2.5 mm. wide, increasing moderately in width for a few mm., and thereafter very gradually. It branches twice, once at 25 mm., and once at 5 mm. from the base. One branch is fragmentarily preserved for a length of 24.5 cm., attaining in this length a maximum width of 9 mm.

Another specimen has been figured, Plate II, showing an impression of this same type matted in the branches of a colony of average size.

Among the algae various types of flotation sacs occur, notably among the Laminariaceæ, but none of these are closely analogous to the bodies here discussed. In the modern north Pacific coast form *Nereocystis lütkeana* (Mertens), elaborately described by MacMillan (1899), there is a very large pneumatocyst at the base of the lamina. In this form, however,

the pneumatocyst and lamina are attached to the bottom by a stout stipe, capable of resisting the force of considerable storms. Remains of no such stipes have been found with the fossil bodies here described.

Among the Dendroidea organs of this type do not seem to have been previously observed. The "disk" of *Dictyonema polymorphum* Gurley (in Bassler 1909) was evidently of a different function, serving the purpose of adhesion rather than flotation. Either modification might be expected to form from the fibrous basal expansions of such species as *Dictyonema crassibasale* Gurley and *D. tenellum* Spencer.

Among the Graptoloidea Axonophora, pneumatophores have been described and discussed by Ruedemann (1904). This group is considered to have led a holoplanktonic existence.

In studying a considerable number of specimens of this species the commonly twisted and matted condition of the whole colony stands out strongly. But a single colony was found that had evidently been dragged straight by a strong current during burial. This colony is the largest observed, two feet in length, as preserved, and incomplete at either end. In this specimen it is probable that the flotation sac, on the death of the animal, collapsed, and that the more compact base acted as a drag, resisting the force of the current, while the loose mass of branch ends was drawn forward with it. Normally, however, the mass of loose branches sank in a mat to the quiet bottom.

It is evident, then, that both in its life and in its preservation this species demonstrates the normal absence of strong currents in the region of Bertie sedimentation. The absence of any means of anchorage made it unfit for life in the strong, regular currents of a river mouth. Such current conditions would be necessary corollary of the delta origin elaborately defended by O'Connell (1916). The most logical view would be that the organism floated in the quiet lagoon waters behind a reef, the rather flexuous branches suspended loosely from the gas-filled pneumatophore.

MEDUSAEGRAPTUS GRAMINIFORMIS (POHLMAN)

Chondrites graminiformis Pohlman, Bull. Buffalo Soc. Nat. Sci., vol 5, no. 1, p. 32. 1886.

Medusaegraptus graminiformis Ruedemann, New York State Mus. Bull. 265, p. 30, pl. 8, figs. 1-4; pl. 13, fig. 1. 1925.

Remarks.—The shattered condition of all but the very smallest colonies of this species contrasts strongly with the excellent preservation of the related *Inocaulis lesquereuxi.* With *Medusaegraptus mirabilis* Ruedemann from the shale lens of the Lockport at Gasport, N. Y., an equal contrast is shown, the preservation of this form being quite as excellent as that of *Inocaulis lesquereuxi.* This excellent preservation of other forms native to the waterlime environment, with the presence of numbers of *Lingula*, argues both quiet water and rapid sedimentation during Williamsville time. The slender, stalky form of *Medusaegraptus* itself may be an adaptation to the latter condition. Ruedemann (1925) has interpreted the conditions of the Gasport channel as including at times strong currents, so that the closely resembling *Medusaegraptus mirabilis* must have been a tough, supple form to enable the skeleton of the colony to remain quite intact against the force of the currents even after death.

SPIRORBIS SP.

Plate IV, Fig. 6

Remarks.—Shells of *Conulariae* and of torticone cephalopods bear the outlines of a *Spirorbis* that seems distinct from any of the described Cayugan species. A specimen in the collection of the Buffalo Society of Natural Sciences is 1.9 mm. in diameter, the last whorl representing half of this distance. Three very rapidly increasing whorls occur, preserving no sign of annulations. Among Upper Silurian species of *Spirorbis* this one seems unique in its very rapidly enlarging whorls.

ANNELID (?) TRAIL

Plate I, Fig. 6

Description.—Shallow, sinuous, no turns sharper than 120°, indistinctly striated longitudinally. Color slightly dark-

er than that of surrounding matrix. The tendency of a thin layer parallel to the surface to peel off, together with the darker color, suggests carbonaceous material mixed with the sediment lining the trail. The specimen is preserved as a cast.

Dimensions.—Width, 1 to 2 cm.; depth 1.5 mm.

Remarks.—In connection with Ruedemann's (1925) description of two annelid species from the Bertie, this track, of distinctly annelid type, is interesting.

HEDERELLA HALL

This genus has not, to my knowledge, been hitherto recorded earlier than the Onondagan. I have observed an undescribed species encrusting cephalopods from the Becraft. The two species described below extend the range of the genus still lower, into the Upper Silurian.

HEDERELLA CF. CANADENSIS (NICHOLSON)

Plate III, Fig. 2; Plate IV, Fig. 2

Aulopora canadensis Nicholson, Pal. Prov. Ontario, p. 124, fig. 57. 1874.

Description.—Zoarium dichotomously branching at rather short intervals. The zoœcia bend off rather sharply for a short distance from the central axis, then frequently bend back to a more or less parallel direction. Distance between zoœcia, along axis, about equal to length of zoœcium. Zoœcia slightly expanding, width at aperture equal to one-fifth of length.

Dimensions.—Length of zoœcium 1.5 mm., distance between branches 4 mm.

Remarks.—No good point of distinction can be found between the present specimen and Nicholson's (1874) rather vaguely defined species. The preservation of the specimen as a mold makes its study and illustration difficult.

HEDERELLA SP.

Plate III, Fig. 3

Description.—Axis straight, rather narrow, branching dichotomously at considerable intervals. Branches for the most part parallel. Zoœcia budding from the central axis at about 20 degrees, usually opposite, cylindrical. They are closely arranged, their sides almost in contact.

Dimensions.—Length of branch 15 mm.; width of axis 0.2 mm., of zoœcium 0.3 mm.; length of zoœcium 1.5 mm.; width of branch 2.7 mm.

Remarks.—In general form the branches of this species resemble those of species of the genus *Reptaria,* but the clear presence of an axis places it with *Hederella.*

RETICULARIA (PROSSERELLA) MODESTOIDES GRABAU

Plate IV, Fig. 5

Prosserella modestoides Grabau, Mich. Geol. and Biol. Surv. Pub. 2, Geol. Ser. 1, p. 139, pl. 16, figs. 22-23, 28-30. 1910.

Remarks.—A single small pedicle valve referable to this species is preserved in the collections of the Buffalo Society of Natural Sciences. The locality is Ridgeway, Ontario, and, judging from the matrix, the horizon that of the Williamsville waterlime. The specimen is an internal cast, and shows the characteristic close, parallel, dental lamellae; barely distinguishable median sinus; and subquadrate outline. The interior of the shell, at least, was without plications. This species was noted by Grabau (1910) from the Anderdon of the Detroit salt shaft, and from the Amherstburg of the Detroit River and of Grosse Isle.

MODIOLOPSIS DUBIUS HALL

Plate IV, Fig. 7

Modiolopsis? dubius Hall, Pal. New York, vol. 3, p. 264, pl. 49, figs. 2a-e. 1859.

Description.—Transversely subovate, length about twice the height, ventral margin very faintly convex, curving broadly in post-inferior region to meet posterior margin. Anterior margin joins the ventral with a short curve, the angle between them being about 90°. Beak not well shown. Cardinal margin straight, rather more than half the greatest length of shell, parallel to ventral margin. Posterior margin decidedly oblique. Greatest length at about one-third above the ventral margin. Beak near anterior end. Post-umbonal ridge low, rather obscure. Valves slightly convex, greatest convexity near beak. Surface ornamented by fine, concentric, growth lines.

Dimensions.—Length 12 mm. Height 6 mm. Thickness about 2.5 mm.

Remarks.—The single shell above described seems to belong to Hall's species, described originally (1859) from the Manlius. This same species is cited by Bassler (1915) under the genus *Goniophora*. In this citation he follows Whitfield (1890). Whitfield, however, based his generic reference on specimens of a quite different species, from the Monroe of Ohio. Whitfield's own description makes it obvious that his specimens were by no means conspecific with Hall's types. Sherzer (1900) and Grabau (1910), who cite *"Goniophora dubia"* from the Monroe of Michigan, reproduce Whitfield's figure, and Grabau repeats his description. There is no record to date of the actual occurrence of the New York species in the Monroe.

The generic placement of this species is uncertain. Reexamination of the types, or of better material from the Manlius, may place it more closely. For the present it seems most fittingly placed in *Modiolopsis*.

METACONULARIA FOERSTE

This genus was erected by Foerste (1928) for thin shelled Conularidae ornamented by very minute grains or papillae, and with each face reenforced by a pair of thin septa close to the median line. In it were placed the following species:

Conularia bilineata Lindström—Gotlandian
Conularia aspersa Lindström—Gotlandian, Lower Ludlow
Conularia granulata Hall—Trenton
Conularia papillata Hall—Trenton
Metaconularia ulrichi Foerste—Platteville
Conularia delicatula Savage—Thebes
Conularia heymanni Foerste—Plattin
Conularia sp. (Foerste 1920)—Plattin

It is interesting to note that of the American species here cited, all but *M. delicatula* are from unquestionably Ordovician deposits, while this last species is considered of Richmond age. Between the Richmond and the Cayugan no American representatives of the genus seem to be known.

The species *Conularia perglabra* Ruedemann (1925) from the Bertie, was originally described as furnished with the paired facial septa characteristic of *Metaconularia*, but as lacking ornament other than fine growth lines. New material described below, together with re-examination of the types, shows that this species in fact possessed a reticulate pattern of fine grooves that represents but little modification from the papillose ornamentation of such species as *Conularia aspersa* and *C. bilineata*.

METACONULARIA PERGLABRA (RUEDEMANN)

Plate I, Fig. 2

Conularia perglabra Ruedemann, New York State Mus. Bull. 265, p. 69, pl. 22, figs. 5-6. 1925.

Remarks.—The collection of the Buffalo Society of Natural Sciences contains a specimen of this species which shows well a distinctive surface ornament. Ruedemann's original description (1925) notes the smooth surface as "the best distinguishing character of the species." The present specimen, however, shows the surface to have been ornamented by a minutely reticulate pattern of sharp longitudinal and trans-

verse grooves, separating pustules of a little more than the width of the grooves. There are about twelve grooves in 1 mm. Toward the aperture the transverse grooves tend to become obsolete, the pattern here becoming one of the fine longitudinal threads. The growth lines in this specimen are arcuate, rather than angular, as in Ruedemann's type.

Through the courtesy of Doctor Ruedemann I have had the privilege of examining the types of this species, now preserved in the New York State Museum. In the holotype (N. Y. S. M. $^{11013i}_{2}$), a small specimen, weathering has almost destroyed the ornamentation. The few patches preserved show the transverse grooves at least as strong as the longitudinal. The syntype figured by Ruedemann (N. Y. S. M. $^{11013i}_{1}$) preserves very well the ornamentation near the aperture, of longitudinal threads slightly finer than in the form here first described. Of four specimens before me, but one shows no trace of ornament other than the growth lines.

ORTHOCERAS (?) SP. A

Description.—Cone very slender, taper remarkably slight, camerae deep, surface apparently smooth, septa straight. Rate of expansion about 3 mm. in 10 cm. length. Siphuncle not preserved. About three camerae in width of conch.

Dimensions.—Length of shell preserved, 15 cm.; maximal width, 11 mm.; depth of camerae about 3.5 mm.

Remarks.—Although very poorly preserved, the very slow expansion, slenderness, and depth of camerae readily distinguish this form from previously known Upper Silurian species. In describing the species *Orthoceras vicinum*, Ruedemann (1916) calls attention to its slow rate of growth, suggested by its slender form and very shallow camerae, as a possible indication of unfavorable growth conditions. With such an interpretation the present form, combining equal slenderness with unusually deep camerae, seems scarcely to fit.

ORTHOCERAS (?) SP. B

Description.—Expansion of cone rapid, about one in five. Surface apparently smooth. The few ill-defined camerae preserved are about 2 mm. in depth. Siphuncle not preserved.

Dimensions.—Length preserved 13.5 cm. Greatest width 27 mm.

Remarks.—This very ill defined orthocone seems to surpass in its rate of expansion all previously known Cayugan forms.

OSTRACODA LATREILLE

In the Bertie the only Ostracoda at all commonly preserved are the members of the genus *Leperditia.* The few occurring, outside of this genus, are invariably preserved only as indistinct molds or casts, the substance of the shell being entirely lost. The heavier shelled *Leperditiae* are fairly common and usually better preserved. The two specimens described below were found covered by the carapace of an *Eurypterus.* The pressure of the overlying sediments has pressed the eurypterid test so closely on the ostracod shells that only the finer surface detail is obscured.

This manner of occurrence is the commonest for all the types of Ostracoda in the Bertie. Parts of eurypterid tests are occasionally noted quite crammed with the shells of ostracods, chiefly forms of *Leperditia.* Scavenging habits are known to occur among the modern Ostracoda, one species, *Cypridina norvegica* Baird, being particularly mentioned by Sars (1928) for its rapacity. Considering these facts it seems probable that these particular eurypterid tests represent dead and partially dismembered bodies on which the ostracods were feeding. That instances of this association of eurypterid tests with ostracods are not more common is but to be expected, if the accepted view, that the majority of the tests found fossil represent, not dead animals, but mere moulted skins, is the true one.

ZYGOBEYRICHIA CF. REGINA ULRICH & BASSLER

Plate IV, Fig. 4

Zygobeyrichia regina Ulrich and Bassler, Maryland Geol. Surv., Silurian, p. 645, pl. 54, figs. 1-2. 1923.

Remarks.—A single right male valve shows the proportions and the straight ventral outline characteristic of this species. Length 2.5 mm., height 1.5 mm. The type of the species is from the Tonoloway of Maryland.

EUKLOEDENELLA SP.

Plate IV, Fig. 3

Description.—Outline almost rectangular, dorsal margin straight, meeting the posterior at a right angle. The anterior margin is strongly arcuate, joining the dorsal in a short curve, the ventral in a somewhat longer one. The posterior margin, dropping straight from its junction with the dorsal, joins the ventral with a very short curve. The ventral margin is straight. The median sulcus is slightly behind the mid-length, extending about half the width of the shell.

Dimensions.—Length 1.0 mm. Height 0.5 mm.

Remarks.—This specimen may be referred to the group of *Eukloedenella umbilicata* Ulrich & Bassler. It apparently represents a new species, distinguished by its regular, elongated form, and its long, straight, ventral margin.

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PLATE I

Fig. 1. Annelid (?) Trail. Large slab of Waterlime with trail. x 0.25.

Fig. 2. *Metaconularia perglabra* (Ruedemann). Enlargement of surface showing remnants of ornament, double median facial groove, and lateral groove. Syntype. N. Y. S. M. $\frac{1}{11013i}$ x 20.

PLATE II

Inocaulis lesquereuxi (Grote and Pitt). Average sized colony as ordinarily preserved with flotation sac in center. B. S. N. S. 13291. x 0.5.
E1620

PLATE III

Fig. 1. *Inocaulis lesquereuxi* (Grote and Pitt). Flotation sac and part of the base of the colony. B. S. N. S. 13289 . x 1.
E1618

Fig. 2. *Hederella* cf. *canadensis* (Nicholson). A group of branches. B. S. N. S. 13342 . x 5.
E1671B

Fig. 3. *Hederella* sp. B. S. N. S. 13342 . x 3.75.
E1671A

Inocaulis lesquereuxi (Grote and Pitt). Average sized colony as ordinarily preserved with flotation sac in center. B. S. N. S. 13291 . x 0.5.
E1620

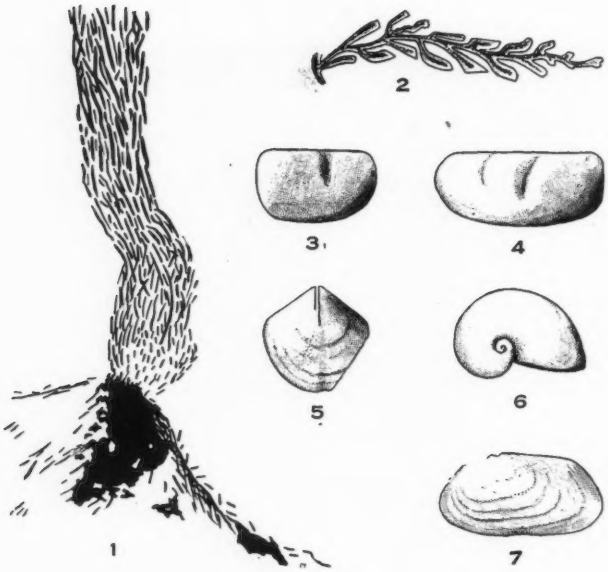

PLATE IV

Fig. 1. *Inocaulis lesquereuxi* (Grote and Pitt). Union of flotation sac and base of colony. Same specimen as shown on Plate III, Fig. 1. x 4.

Fig. 2. *Hederella* cf. *canadensis* (Nicholson). Single branch from the colony shown on Plate III, Fig. 2. x 4.

Fig. 3. *Eukloedenella* sp. B. S. N. S. $\frac{11510}{E1025}$. x 20.

Fig. 4. *Zygobeyrichia* cf. *regina* Ulrich and Bassler. B. S. N. S. $\frac{11510}{E1025}$. x 10.

Fig. 5. *Reticularia (Prosserella) modestoides* Grabau. Specimen from near Ridgeway, Ontario.

Fig. 6. *Spirorbis* sp. B. S. N. S. $\frac{13342}{E1671A}$. x 10.

Fig. 7. *Modiolopsis dubius* Hall. B. S. N. S. $\frac{15831}{E2881}$. x 2.

APPARENT GASTROPOD TRAILS IN THE LOWER CAMBRIAN

CARROLL LANE FENTON AND MILDRED ADAMS FENTON

The absence or extreme rarity of snail shells in faunas of early and middle Cambrian age necessitates a consideration of trails as possible records of gastropods prior to the late Cambrian. It is well known that some trails attributed to annelids closely resemble those made on modern seashores by periwinkles and others snails.[1] Since "annelid" trails are abundant in middle and lower Cambrian strata, especially of the Rocky Mountains, examination of them for the possibility of gastropod origin seems to be in order.

During the summer of 1930, we found at least one formation of early Cambrian age in which the ichnite evidence of snails seems to be conclusive. At Ross Lake, British Columbia, about one mile south of Stephen station, on the Canadian Pacific Railway, there are several large blocks of rock which have fallen from the member of the Mount Whyte Formation which is numbered 4 in Walcott's section of the exposure.[2] They consist of yellowish shaly or micaceous sandstones interbedded with greenish sandy shales. Surfaces of strata bear ripple marks which suggest the waves and currents of a broad yet embayed tidal flat; and these surfaces bear abundant markings which are the "annelid trails" of Walcott's section. In addition, there are numerous pits and low mounds which mark the apertures of *Scolithus*-like burrows, made by annelids with the habits of the living *Arenicola*. We were not so fortunate as to find tracks of trilobites, although Walcott says that they are present, but rare.

Examination of the trails, which differ in size from layer

[1] See P. E. Raymond, Am. Journ. Sci., vol. 3, pp. 109-112, 1922; also L. D. Burling, *ibid.*, vol. 44, pp. 390-398, 1917.

[2] Smithsonian Misc. Coll., vol. 75, pp. 306-308, pl. 66, 1928.

to layer, but are more or less uniform upon any given surface, shows that each consists of three distinct parts. Medially there is a flattened furrow which, in the more nearly perfect trails, bears low transverse ridges. The furrow is bounded by two rounded ridges, whose height is virtually uniform throughout their length. As may be seen from the photographs, the trails do not bend and twist as do those of wriggling annelids, nor do they bear any traces of the action of appendages. Being filled by the sands of superjacent layers, there is no possibility that they are elongate burrows.

But a few weeks before our visit to Ross Lake, we had photographed the trails of periwinkles (*Littorina sitchana* Philippi) crawling about a sandy tidal flat on San Juan Island, Puget Sound. We found in them the same structures which mark the trails in the Mount Whyte sandstone. On smooth or regularly rippled surfaces, the snails crawl in straight or broadly curving paths which commonly cross. The width of the furrow depends upon the size of the foot and body whorl of the gastropod; its depth (and the height of the bounding ridges) seems to be determined primarily by the compactness of the sand. Where the sand is loose, with abundant water, the flatness of the furrow does not persist; within a few minutes after the passage of the snail the sand which has been pushed into ridges slumps into the furrow, giving it a broadly V-shaped section. This occurs most readily in the furrows between ripple marks—a feature also apparent in the Cambrian trails.

Because of these similarities, therefore, we conclude that the lower Cambrian trails of the Ross Lake section were made by snails rather than by annelids, as Walcott supposed. We make no effort to determine whether the snails belonged to one species or several, for the only differences which are apparent (those of size) are inadequate for differentiation. Nor is it clear whether our hypothetical gastropods were naked or bore shells. If the resemblance of the trails to those of the thick-shelled *Littorina* is taken to indicate the latter condition, it still does not follow that the shells were so robust

as are those of that genus. More probably the shells were very thin, and so incapable of preservation in the Mount Whyte sands, or in the Ross Lake shales of the Ptarmigan Formation, higher in the section.

Nor need scavengers be called upon to effect their destruction. Shells of both snails and mussels disintegrate rapidly in sands containing even small amounts of hydrogen sulphide. In the sands of our *Littorina* locality in Puget Sound, digging discloses few shells of snails; yet conditions of sedimentation seem to differ but slightly from those of the Mount Whyte Cambrian sands. Darker beds, such as the Ross Lake shale, give evidence of having possessed enough hydrogen sulphide to have destroyed shells much more resistent than those which we reasonably attribute to snails of the early and middle Cambrian.

FIG. 1. Surface of a bed of Lower Cambrian (Mount Whyte) sandstone at Ross Lake, near Stephen, B. C. It bears numerous trails apparently made by gastropods, as well as pits indicating the nearly vertical tubes of Arenicoloid annelids.

FIG. 2. *Littorina sitchana* Philippi crawling upon wet sand in the intertidal zone, San Juan Island, Washington.

A SMALL COLLECTION OF PLEISTOCENE MAMMALS FROM LAPORTE COUNTY, INDIANA*

MARCUS WARD LYON, JR.

Mr. Henry Duncker, at 947 Lincoln Way East, South Bend, Indiana, has among other curios in his home, remains of several specimens of Pleistocene mammals from Laporte County, Indiana. As these are in a place where they escape the ready notice of those interested in them, and as none of the four species represented among them have previously been reported from Laporte County, it seems desirable to call attention to them. They were all collected by Mr. Duncker from the sides of the ditch that was dug when the Kankakee marsh was drained. They were found in the south-eastern part of the county. Mr. Duncker thinks that none of them occurred at a greater depth than ten feet from the surface of the ground or what used to be the bottom of the old Kankakee marsh. They were evidently all deposited in the old glacial Lake Kankakee. These remains are as follows:

Virginia Deer, *Odocoileus virginianus* (Boddaert)

1. Almost perfect skull without lower jaw. The premaxillae and part of left antler are wanting. Two views of this skull are shown on next page. It is an adult male. For comparison with other specimens the following measurements are given:

Greatest length of nasals,	105 mm.
Length of maxillary toothrow, alveoli,	83 mm.
Greatest width between outside surfaces of teeth,	85 mm.
Back of condyle to anterior end of maxilla,	260 mm.
Zygomatic width,	120 mm.

* Read at the 13th annual meeting of the American Society of Mammalogists, at Philadelphia, May 12-15, 1931.

Virginia Deer Skull Pleistocene, Laporte County, Indiana.

Antero-posterior diameter of orbit,	42 mm.
Least interorbital width,	70 mm.
Distance between tips of paroccipital processes,	67 mm.
Occipital depth,	70 mm.
Maximum width between orbits on dorsum of skull,	90 mm.
Maximum width between orbits,	125 mm.
Maximum thickness of right antler, above burr,	42 mm.
Maximum thickness of left antler, above burr,	42 mm.
Distance between outer edges of occipital condyles,	55 mm.
Distance between inner surfaces of antler pedicels,	65 mm.
Right antler, length along convexity,	655 mm.
Greatest width of antlers,	470 mm.

2. Fragment of antler of another individual.
3. Fragment of antler of another individual.
4. Fragment of antler of another individual.

American Elk, *Cervus americanus* (Erxleben)

Whether the remains listed below all belong to the same individual it is impossible to say. The remains were rather widely scattered. The animal was not of large size. No skull is present. The limb bones certainly all came from the same animal and are remarkably well preserved. The material with measurements:

1. Right antler, fragment,

Length of brow tine,	180 mm.
Circumference of antler above burr,	140 mm.
Circumference of antler between brow tine and the imperfect bez tine,	100 mm.

2. Right and left humeri,

Length between most distant points,	300 mm.

3. Right and left femora,

Length between most distant points,	355 mm.

4. Right and left tibiae,
   Length between most distant points, 390 mm.
5. Right and left innominate bones,
   Maximum length, 375 mm.
   Size of thyroid or obturator foramen, 90 x 50 mm.
6. Six vertebrae well preserved and a number of ribs.

United-Horn Musk-Ox, *Symbos cavifrons* (Leidy)

Large fragment of the skull, all anterior portion missing, no teeth, left horn corn missing, lower jaw lacking. An almost perfect atlas is present whose articular surfaces fit with extreme accuracy the perfect condyles of the skull.

Width of back of cranium,	205 mm.
Paroccipital width,	150 mm.
Width between outer surfaces of condyles,	120 mm.
Tip of right horn-core to plane of middle line of skull,	270 mm.
Length of horn-core along convexity from middle line of skull in front to tip,	440 mm.
Depth of skull posteriorly,	225 mm.
Interorbital width, estimated,	200 mm.
Circumference of horn-core at base,	260 mm.
Width of back of skull at base of horn core,	135 mm.
Atlas, maximum width,	210 mm.
Atlas, maximum length,	200 mm.
Atlas, diameter of foramen, posteriorly,	60 x 60 mm.
Atlas, diameter of foramen, anteriorly, dorso-ventrad,	30 mm.
Atlas, diameter of foramen, anteriorly, laterally,	45 mm.

American Mastodon, *Mammut americanum* (Kerr)

The mastodon remains may be referred to one individual though possibly more than one is represented by them. Several excellent teeth are among them. The portions are as follows:

1. Much worn tooth with 3 ridges, 80 mm. long by 63 mm. wide.

2. Much worn tooth with 3 ridges, 80 mm. long by 70 mm. wide.
3. Unworn tooth with 3 ridges, 120 mm. long by 90 mm. wide.
4. Slightly worn tooth with 4 ridges, 175 mm. long by 95 mm. wide.
5. Slightly worn tooth with 4 ridges, 170 mm. long by 90 mm. wide.
6. Slightly worn tooth with 5 ridges, 210 mm. long by 100 mm. wide.
7. Atlas, 330 by 215 mm., opening dorso-ventrad 105 mm. and laterally 90 mm.
8. Cervical vertebra, nearly perfect, height 300 mm., greatest est width above 200 mm., greatest width below 290 mm., thickness 60 mm., opening, dorso-ventrad 80 mm., laterally 85 mm., centrum, dorso-ventrad, 160 mm., laterally 150 mm.
9. Lumbar vertebra, rather broken, dorso-ventrad diameter of opening 50 mm., lateral 110 mm.
10. Ribs, two fragmentary, another essentially entire, measuring 1500 mm. along convexity; circumference at neck 125 mm.
11. Scapulae. Right, fragmentary, articular surface 245 by 145 mm. measured along the concavity. Left, nearly entire, about 780 mm. long, 450 wide, articular surface 245 by 150 mm. measured along the concavity.

Horse, *Equus* sp.

Two teeth, each showing considerable wear, probably from the same animal. The smaller of the two teeth was examined by Dr. J. W. Gidley and identified by him as the second right upper molar of a small horse about the size of a pony. The larger tooth is apparently the first right upper molar. Length and width of smaller tooth, 29 by 22 mm., of larger tooth, 32 by 28 mm.

South Bend, Indiana.

NOTES ON THE VEGETATION OF COLUMBIA, MO.

H. W. RICKETT

The region under consideration extends from Columbia about fifteen miles in all directions. This small area includes formations representative of most types found within the state. In spite of its interest, it has apparently been visited by few collectors. Tracy, in his Flora of Missouri [9], includes many notices of Boone county, which in the main corresponds to the region in question, based upon his own collections and upon those of Galloway. We have very few of these specimens; a number are now in the herbarium of the Mississippi A. & M. College, where Tracy apparently carried them, together with collections by Swallow, Bush, and others. We have in the University herbarium a few specimens by Eggert Broadhead, Favor, and others. The chief botanical study of the region was made by Daniels [2, 3], whose specimens are preserved in the herbarium. He listed 1058 species and 47 varieties in 435 genera. Upon examination of his specimens, however, some of these species prove to rest upon misidentifications, and some others are not represented. Some of the species represented have not been found in rcent years, while others which he did not collect are now frequent. A revised list of the flora has been prepared and recently published [8]. Preliminary lists have been published also of the commoner algae [4] and bryophyta [10]. Maneval has recently published a list of certain of the fungi [6], and in the fungus herbarium upon which this list is based are many specimens of vascular plants. It is the purpose of these notes to direct attention to some of the interesting features of the flora and to some of the more important changes that have occurred in our understanding of it since Daniels' work was published.

To the north and east of Columbia extend flat lands characterized by the remains of a prairie vegetation, interrupted

by wooded or broken areas. Some fifteen miles east on U. S. highway 40 is a considerable area of virgin prairie, which affords several species absent or infrequent in other parts of the region, namely: *Scirpus validus, Juncus brachycarpus*, Melanthium virginicum*, Baptisia bracteata, Lespedeza capitata*, Polygala sanguinea, Eryngium yuccifolium*, Acerates viridiflora lanceolata*, Verbena hastata, Cacalia tuberosa;* while *Amorpha canescens* and *Ruellia carolinensis* are far more abundant here than elsewhere. *Silphium laciniatum* is limited in its distribution to certain roadsides east of Columbia.

Fifteen miles north occur the picturesquely eroded bluffs known as the Pinnacles. They lie on a ridge which traverses the country in a general east and west direction, and within the southern limits of the glaciated area. Several species have been recorded here which are not found elsewhere near Columbia. On the Pinnacles is our only station of *Arenaria texana stricta* (compare the rock vegetation of the Missouri River bluffs). Here also occur *Viburnum affine** (Daniels' *V. dentatum*), *Dodecatheon Meadia, Myosurus minimus*, Pycnanthemum virginianum. Gentiana Andrewsii* was reported by Daniels from sandy flats (1898) and from a swamp (1907; this swamp has since disappeared); in recent years the only plants seen were on roadside banks at the Pinnacles and near Hallsville.

To the east and southeast and at a distance of from ten to fifteen miles lies Cedar creek, with its tributaries. Near Ashland the bluffs and hills of these valleys are higher and more rugged than those of the creeks nearer Columbia, and afford several species not found elsewhere in the region. The particular part most visited in recent years is near Dulle Mill, where are high and precipitous bluffs, meadows and a wooded knoll surmounted by an Indian mound. At the top of the

* Not previously reported from the Columbia region.

bluff occur *Quercus marilandica* and *Q. stellata*. By the side of the steep road which descends into the valley are found *Astragalus canadensis, Petalostemum purpureum, Psoralea tenuiflora, Rhus copallina, Specularia leptocarpa*, Parthenium integrifolium*, of which all are infrequent in other parts of the Columbia region, and the Specularia has been seen nowhere else. At the base of the cliff occur *Hydrangea arborescens**, and *Cornus alternifolia**. In a field was found *Nicotiana physalodes*, reported by Tracy but not found by Daniels. Across the stream on the sides of the knoll is a moist bank which supports an abundance of *Hepatica acutiloba*, otherwise known only from a deep ravine near the Pinnacles. Here also *Cypripedium parviflorum* was rediscovered (having been earlier reported but not seen for many years), and a colony of *Liparis lillifolia** was found.

Several of the above species are suggestive of Ozarkian affinities. The forest flora of the Ozarks has been described by Palmer [7]. In many parts of the Missouri Ozarks occur high and dry plateaus characterized by the two oaks named above; and the tops of many of the hills are similar in this respect. *Rhus copallina* also is common. Near the watercourses *Hydrangea* is frequent; and in the woods orchids are occasionally found (*Spiranthes, Calopogon, Cypripedium, Corallorrhiza, Habenaria*, etc.)

South of Columbia to the Missouri River extends a broken country drained by many small streams. This is the region particularly referred to by Daniels (1907) in his characterization of the country as exhibiting "tension between forest and prairie." The more level, uneroded portions represent extensions of the prairie area to the north and east. Daniels' account of this region seems to be fairly complete. *Sedum purpureum**, growing on stony hillsides, may be added to the flora. *Orchis spectabilis* was reported by Tracy, but not found by Daniels. It was rediscovered in 1925 by several collectors,

* Not previously reported from the Columbia region.

and since then has been several times observed; but frequently has not been found in the same place in successive years, which suggests that it may bloom at irregular intervals. The most striking association is found on a few hill tops composed of red shale, and includes *Quercus marilandica, Q. stellata, Viola pedata* with its var. *linearilobа, V. triloba* with its var. *dilatata* (Daniels' *V. palmata*), *Dicranum scoparium, Leucobryum glaucum, Climacium americanum* (for the distribution of the mosses see Zirkle et al.), and a characteristic lichen as yet unidentified. This group of plants occurs also on a high point near the Pinnacles. I have seen exactly the same association on a high bluff overlooking Maramec spring in the Ozark region, and doubtless it exists also elsewhere.

To the south and west of Columbia lies the Missouri River, commonly reached at Rocheport, fifteen miles west, and at Providence, ten miles south. A line of imposing bluffs limits the valley, and affords our only stations of *Mentzelia oligosperma* and *Houstonia augustifolia*. At the foot of the bluffs run the tracks of the M. K. & T. R. R. Here are species not found elsewhere near Columbia, of which many have probably used the railroad or the river in their migration. Among these are *Froelichia floridana*, Anemone canadensis* (reported by Tracy but missed by Daniels), *Ranunculus sceleratus*, Callirhoë alcaeoides*, C. involucrata*, Spermolepis patens*, Gaura parviflora*, Oenothera speciosa, Ipomoea coccinea*, Lithosperum angustifolium** (which Daniels mistook for *L. officinale*), *Hedeoma hispida*, Solanum elaeagnifolium*, Cucurbita foetidissima.*

In the dry seasons large flats appear in the river. These have continually changed their size and shape as the river fluctuated in its course, and the moist margins of newly deposited flats have a characteristic and interesting vegetation, most of which is reported by Daniels. *Rumex maritimus fue-*

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* Not previously reported from the Columbia region.

*ginus** (Daniels *R. persicarioides*) here appears, with *Polygonum* spp., *Acnida tamariscina**, *Ammannia coccinea*, *Mentha piperita*, *Gratiola neglecta*, *Ilysanthes* spp. and *Bidens* spp. (particularly *B. cernua*). On the flats proper willows appear first, newly deposited land being frequently covered with dense stands of *Salix longifolia*. The effects of competition and invasion are strikingly evident in these colonies. Young plants less than a year old have been found to number from 150 to 170 per square meter, with no other species present. The same general location six months later showed not more than 70 and in places as few as 2 per square meter, the surface being covered largely by the dead stalks (as many as 140 per square meter) and by invading plants of *Erigeron canadensis*. The death rate was doubtless accentuated by the severe drought of 1930, during which these counts were made; but the figures are in substantial agreement with conditions observed in older colonies. In thrifty colonies three years old the number of trees per square meter varies from 5 to 15 (to 25 at the margins). Occasional plants of *Populus balsamifera virginiana* appear in the older colonies. Much older associations, comprising many species, exist on flats near Rocheport and Providence; these probably began in the same way many years ago, and await study.

For the Columbia region as a whole many changes must be made in Daniels' list. This is particularly evident in the genera *Panicum*, *Carex*, *Crataegus* and *Vernonia*. Some notes on the more outstanding changes may be proper here.

Our collections of *Bromus* are of particular interest. *B. inermis*, collected by Favor from the University farm, is represented by the only collection, to my knowledge, from Missouri. Daniels' *B. hordeaceus* is *B. japonicus**, not previously known from the state. It seems to be now common.

In *Panicum* Daniels listed sixteen species, of which three

* Not previously reported from the Columbia region.

are now commonly segregated as *Digitaria* and *Echinochloa*, and nine others cannot be maintained. The present list numbers fourteen. Under the names *P. columbianum*, *P. implicatum*, *P. dichotomum* with four varieties, *P. nitidum*, *P. lanuginosum* and *P. commutatum* are found *P. huachucae** with its var. *silvicola**, *P. tennesseense**, *P. sphaerocarpon**, sometimes two species on the same sheet and with the same label.

The number of species of *Carex* is small as compared to the number known from the state, but the local species are of interest. Bush has recently published [1] a review of Daniels' specimens and others in the University herbarium. One of our commonest sedges is *C. heliophila* (Daniels' *C. pennsylvanica*). Daniels' *C. laxiflora* is in part *C. hitchcockiana* and in part *C. albursina*, while his *C. laxiflora varians* is *C. blanda*. His *C. tenera* is *C. festucacea*, while some of his *C. straminea* is actually *C. tenera*, the only specimen known from the state. *C. microrhyncha* (Daniels' *C. umbellata vicina*), and *C. tribuloides sangamonensis* (Daniels' *C. tribuloides* vars.) are also, I believe, here represented by the only collections from central Missouri.

In the determination of the species of *Crataegus*, it is frequently necessary to examine the flowers, fruits and leaves from a single plant. Daniels' collections bear no labels which allow of such study, so that it is impossible to identify all the species with certainty. Certainly some of his species do not occur here, while others (*C. Crus-galli*, *C. tomentosa*) represent complexes of separable species or varieties yet to be determined. In this genus, as in *Vernonia* (see below) little progress can be made by the taxonomist unassisted by cytologic and, if possible, genetic work; many of the species have been shown to exhibit cytological features commonly associated with hybridity, and their constancy is problematic.

On pages 218 to 223 of the Flora [3], Daniels proposes eight

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* Not previously reported from the Columbia region.

new species of *Vernonia*. Of these six are allied to *V. Baldwini*, while one is placed in the Drummondiae with *V. interior* and *V. missurica*. These "species" are differentiated chiefly by leaf-shape, color of pappus, and shape of bracts; the latter is described as "oblong" for two species in his key (p. 259) and as "ovate-lanceolate" and "lanceolate, long acuminate" for the same species in the descriptions (pp. 220, 221). Gleason [5] has shown that *V. interior* and *V. Baldwini* are related as varieties. This species, with *V. illinoensis* and *V. missurica*, exhibit intergradations in the characters mentioned above, a variation which may be due to hybridization, to mutation, or to environmental factors. Under such circumstances the species-names can be applied only to recognizable extremes which prove relatively stable. Even the assigning of varietal rank to Daniels' species would be of doubtful value. When one turns to the specimens, the situation becomes even more muddled, for Daniels recognized also numerous "hybrids" between his species (most of these he did not mention in the Flora). Obviously the whole situation is in need of careful study; but with such variable entities as these, such study must involve cultural tests of the various forms. Genetic and cytologic evidence must supplement the taxonomic before one can decide that the species of Vernonia hybridize or mutate and that the wealth of intergrading forms is due to hybridization or to other causes. Pending such work, Daniels' species have been grouped under the described species or varieties to which they most nearly approach, according to Gleason's descriptions. Similar remarks apply to another "new species," *V. chrysopappa*, which is evidently related to *V. fasciculata*. Of all Daniels' proposals, that most entitled to serious consideration is *V. parthenioides*. The leaves of the herbarium specimens are mostly glabrous or glabrate and present an entirely different aspect from those of related species; here also, however, there are intergradations and "hybrids," so that, even if this proves to be recognizably distinct and fairly

§ Frequent in the Ozark region.

constant, it should probably be designated as a variety of *V. Baldwini* (which it closely resembles in most respects).

Several of the species listed by Daniels have not been recently encountered. They may have disappeared from the region, and were probably represented by occasional stragglers from other parts of the state. Several are at present common Ozark plants. Among the missing species are the following: *Notholaena dealbata* (found once by Daniels on the Missouri river bluffs, and since sought in vain); *Ophioglossum Engelmanni* (Daniels' *O. vulgatum;* since his time found in the station to which he refers, but in recent years sought in vain); *Erythronium americanum; Lilium superbum; Trillium erectum; Iris* spp.;§ *Aplectrum hyemale; Salix humilis; Alnus rugosa;*§ *Nymphaea odorata; Thalictrum dasycarpum; Benzoin aestivale;*§ *Lathyrus palustris myrtifolius; Vicia Cracca; Callitriche deflexa Austini; Cornus candidissima; Vaccinium vacillans*§ (found by Daniels on certain bluffs near Gridstone creek, where it has been recently sought in vain; the location, however, was inadequately described); *Centunculus minimus; Steironema radicans; Sabatia campestris; Monarda citriodora* (from the R. R. tracks near Rocheport); *Castilleia coccinea;*§ *Lobelia cardinalis;*§ *Crepis setosa; Eupatorium coelestinum;*§ *Silphium terebinthinaceum;*§ *Tragopogon porrifolius; Vernonia crinita.*§

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§ Frequent in the Ozark region.

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SOME UNUSUAL OBSERVATIONS OF CORN SEEDS DURING GERMINATION

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Germination is receiving a great deal of attention at the present time, particularly with reference to dormancy and the chemical changes. Some extensive experiments, pertaining to the latter phase, have been undertaken in this laboratory. During this work, some unusual results have been obtained, which do not seem to have been recorded before. Yet they may be important in germination and early growth of corn seedlings, because they might cause an experimental error or errors in interpretation results derived from such studies.

Corn seeds, irregularly shaped, taken from the tip or the butt ends of the ear, especially those in which embryos are located at the sides rather than in their usual position, seldom if ever germinate. Even those which may germinate, usually require a longer period than the normal ones.

Several authors have shown that heavier seeds of the same species are more satisfactory to germinate because they may be more matured and fully developed. The writer agrees with them as far as normal corn seeds are concerned. However, poorly developed seeds with abnormal location of embryos, even with heavier weights, have not proved to be satisfactory in the writer's experiments; first because they lower the rate of germination and second because they slowly germinate, thus extending the time duration. Many experiments, especially those in which duration of time is of prime importance, the use of such seeds, even from the same ear of corn and in spite of their heavy weights, may be a source of experimental error. The range of such an error, at times, exceeds 20 to 25 percent.

In the middle of some corn ears, a number of compressed, thin, undeveloped and starved seeds may be found. They seem to germinate somewhat faster than the normal seeds, probably because of their thin surfaces, through which water is permeable. Their seedlings, on an average, show poor growth

both on the basis of dry weight and the total length of the shoot and the root. This tendency may be attributed, in part, to improperly nourished embryo, and less food contained in the undeveloped endosperm. In such experiments, where seedlings or matured plants are proposed to be employed, the use of such seeds may also cause an error.

These studies have also shown that experiments in which seeds are treated with X-rays or ultra-violet rays, position of corn seeds with reference to the source of radiation is of great importance. A seed with the position of the embryo away from the light (towards the container or the plate) is less affected by the treatment than the seed with the embryo directly placed towards the light. By repeated experiments it was found, that favorable or adverse effect of these rays (depending upon the duration of exposure and the wave length) may be entirely different, because of the side of the seed exposed. This seems reasonable, since corn embryo is not equally exposed in the two sides of the seed coat. The side which is more exposed is affected most and vice versa. At times (with wave length of 200 u. u. and exposure of 15 minutes) a 60 percent difference was noted due to this factor alone.

These results seem to point out, that in corn germination studies, the use of the tip and the butt end and uneven seeds with unusual location of embryos, should be avoided. Compressed seed as found in the middle of the corn ear cause an error in germination studies.

In the radiation experiments with reference to the corn germination, seeds from the embryo side may be exposed towards the rays for more effective and uniform results. The detailed results will appear in the Proceedings of the Royal Soc. in due course of time.

Acknowledgements are due to Mr. James Kelly, of this institution for his help rendered in connection with some of these experiments.

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Book Reviews

PHYSIOGRAPHY OF WESTERN UNITED STATES, by Nevin M. Fenneman. New York and London: McGraw-Hill Book Co., 1931. xiv+534 pp. $5.00.

To the reviewer who dislikes to write mere notices of books, Dr. Fenneman's *Physiography of Western United States* presents a very difficult task.

Perhaps he should confine himself to commenting upon the wide range of information presented in these 534 pages, the numerous clearly-drawn maps and diagrams, and the photographic illustrations, which are carefully chosen and in the main, well printed. He might comment that for seven different regions concerning which he had much curiosity and little information he found, via the copious index, treatments quite adequate to his needs, supplemented by references which facilitate further study.

Yet perhaps there is one field in which comment may be made, suggestive criticism offered. The naturalist, no less than the geographer, is concerned with land forms as a background of populations, interrelations, and activities. To the biogeographer as well as the ecologist, some knowledge of land forms and their causes is essential.

I do not think that any book in English, written from a biologic viewpoint, gives a great deal of the information, even about the United States, which the working naturalist will want to use. The most likely exception to this statement is the admirable *Naturalist's Guide to the Americas*, published in 1926 under the auspices of the Ecological Society of America; yet it does not attempt to go beyond the topography of selected regions and political units. For its purpose,

this treatment is excellent; yet the naturalist who travels with the *Guide* in his briefcase library soon will find himself in need of a physiographic handbook which interprets as well as describes terrestrial habitats.

Such a handbook, for the western half of the United States, Dr. Fenneman has provided. The preface states that a companion volume for the section east of the Great Plains is in preparation—and one hopes that either Dr. Fenneman or other authors will continue the work until it describes the physiography of the entire continent of North America. Yet, even if that is not accomplished, the two books which are assured will form units in the library of the field biologist whose value will rank with that of the *Naturalist's Guide*—if they do not exceed it.—Carroll Lane Fenton.

TAXONOMY OF THE FLOWERING PLANTS, by Arthur 8vo. pp. XXI+864. figs. 478. The Century Co., New York and London. 1931. $7.50.

Dr. Johnson's book is unique among recent texts, treating the taxonomy of flowering plants. There is neither a new system proposed nor is the work extremely conservative. It is written chiefly from the standpoint of teaching taxonomy. The author gives all his attention to the proper selection and organization of the subject, trying to eliminate the "objectionable features" as much as possible. This was done in a rather free manner thus "breaking away from orthodox methods." Furthermore, all illustrations were drawn by the author whom the reader learns to know as a skilful artist. These excellent pen and ink sketches represent a great deal of the book's merits as well as they prove the writer's views regarding the "diagnostic" characters and their importance for teaching taxonomy successfully.

The system adopted is in the main the one of Engler and Prantl, so generally in use. However, only the sequence of the families is followed while accepting the major groups of Rendle as the best "workable system." Several features of the

systems of Warming and Wettstein had been included, thus combining various advantages of each. The manifold phylogenetic problems are not discussed in too much a detail and yet the student is consistently kept aware of the underlying idea of phylogeny. Whatever system one may follow or prefer the author's treatment is to be congratulated. The added Glossary is clear, sufficient and carefully made up. The Bibliography is well selected and suitably arranged. The unique character of the book merits recommendation to every botanist.—Theodor Just.

BLATCHLEYANA.—A List of the Published Writings of W. S. Blatchley, Together with a Chronology of his Life: the Fixation of Types of New Genera and Species Described by him, etc., pp. 1 - 77; two portraits. The Nature Publishing Company, Indianapolis, 1930.

This brochure was published as a helpful guide for the fellow workers of the author. A detailed chronology of the life precedes the respectable bibliography, covering all the scientific as well as other writings, including the extensive editorial work and numerous newspaper articles pertaining in some way or other to science. The reader learns through this enumeration about the manifold activities of a man who has been gifted with a long and successful life.

Of special value to the taxonomist are the various lists of animals first described by the author, arranged chronologically and alphabetically, including citations, types and synonyms. There is also "A List of Genera, Species or Varieties Dedicated by Other Authors to W. S. Blatchley." Throughout the booklet are reprints of letters, relative to the work, or publications by various prominent men, parts of the author's writings, together with selections of poetry. All these give a very strong personal impression of a man whose work, it is to be hoped, has not terminated with this autobiographic sketch.—Theodore Just.

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